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ABSTRACT

This paper examines some of the findings of selected pertinent reports concerning the nature of women scientists and engineers conducting research. It also looks at women employed in academic institutions, in industry, and in government. Some changes over time are shown in the paper for the periods where comparable data exist, including a discussion of salaries as a fringe indicator of the status of women scientists and engineers. Available data on the labor force participation of women scientists and engineers is examined and questioned, and the findings are summarized. Tables and their interpretation are included in the text. Recommendations regarding future data collection are incorporated at the end of the summary of findings. Some of the findings indicate that more men than women were employed in research and development in 1977, proportionately more women scientists and engineers than men are employed full-time in universities, and women scientists and engineers earn less than men and this salary gap is increasing. (MA/Author)

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DATA ON WOMEN IN SCIENTIFIC RESEARCH

by

Betty M. Vetter

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by

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INTRODUCTION

The problem posed for this research was to delineate the characteristics and activities of women scientists and engineers engaged in research, both in comparison to other women scientists and engineers and to men engaged in research, by examining and analyzing all available data. Further, an effort to view changes over time in these characteristics was included in the problem, in order to examine the progress of women in science and engineering research, whether that progress was forward or backward. One additional task was to try to see whether minority women differed from majority women scientists and engineers who were engaged in research.

It became almost immediately evident that the available data base is inadequate to study the problem as outlined. Where information is available by sex, few of the characteristics needed for this analysis have been tabulated. Where information exists delineating research scientists and engineers from those performing other activities, data are rarely available by sex. Differences in minority and majority women researchers cannot be illuminated, because no data exist to provide such differentiation.

Thus, the research takes on the characteristics of a double jigsaw puzzle from which a third picture must emerge. The first puzzle shows a picture of scientists and engineers involved in research, including a background showing their employment setting, with the individuals pictured as sexless. The second puzzle is a picture of women scientists and engineers with most of the pieces missing that might have shown their activities in various settings. We can count the numbers, but where the setting is evident, we cannot see what most of these women are doing; and where we can see their activity, we cannot tell where it is taking place.

Some pieces are missing in both puzzles, and a few pieces are congruent to both puzzles. The picture to be made by the research, thus, not only must surmise the characteristics of some of the missing pieces from the available information, but ultimately leaves large holes where no information is available to fill in the spaces.

The attempt to view changes over time generally encompasses only a short time interval, since comparable data over long time periods exist for only a few variables, none of them directly related to women scientists and engineers who are engaged in research.

Data Sources and Reliability

The vast majority of the data available on scientists and engineers working in research is collected by or for the National Science Foundation. Data by sex that deals with the doctoral population is more detailed and more reliable than data by sex from other surveys done by or for NSF, since the sample used to study the characteristics of the doctorate population was carefully selected to include a sufficient proportion of women to provide validity when data are broken out by sex. Other samples, such as the National Sample used by the National Science Foundation as part of its Manpower Characteristics System, were selected at an earlier point in time without regard to appropriate sample size of women to provide data by sex. The proportion of all scientists and engineers who are women is small. Thus, samples that do not include larger numbers of women than their proportion in the total introduce a significant sampling error when specific characteristics are broken out by sex.

Except for surveys of the doctorate population, which will continue to maintain a carefully weighted sample to provide data on men and women separately, no major change in most of the samples used for continuing series surveys of the science and engineering population will be possible prior to the 1980 Census. When the National Sample for the next decade is selected, a special effort should be made to insure a sufficient number of women in the sample to allow detailed statistical analysis by sex.

In part, because sample sizes for women in science and engineering are small, and in part because a demonstrated need sufficient to warrant the extra cost of collecting, tabulating and analyzing more data has not been recognized by these agencies, much data collected by and for NSF and other government agencies which includes gender identification is never tabulated by sex. Thus, demographic variables which may be significantly different for otherwise comparable men and women scientists and engineers are neither noted nor evaluated.

The questionnaires used for surveys of total populations (such as employment of scientists and engineers by academic institutions) often do not include request by sex of those variables which can be cross tabulated to provide an understanding of the data results. For example, the finding of this study that a higher proportion of women scientists and engineers is employed in succeedingly higher groups of universities employing scientists and engineers cannot be explained satisfactorily because no information was requested by sex on degree level, academic rank or such fringe indicators as salary of these scientists and engineers. Information on academic faculty by field, rank, type of institution and sex is not available for cross checking.

In some cases where the sex variable was requested by the survey instrument, cross tabulations of other variables by sex were not made because the female proportion in the sample for any particular variable was too small to provide reliable data. For example, the number of women scientists and engineers employed in industry is so small that the standard samples of this population unaugmented by oversampling for women, cannot be further delineated by principal activity, by degree level or other such variables because such tabulations would produce data cells too small to be weighted reliably.

Data collection and analysis is expensive - and the analysis grows more expensive and time consuming with each additional variable analyzed or cross-tabulated. Partly for this reason, many of the surveys used in this study did not request or did not analyze the variables needed for this particular research.

Thus, because the sample base for women is too small, because the agencies have not recognized a need for more detailed data delineating women from men, and because the cost of collecting and analyzing more data has not been justified; the data base for studying the characteristics of women scientists and engineers in relation to men and in relation to similar women in other fields is inadequate; the data base necessary to study that particular segment of women scientists and engineers working in research is almost non-existent.

Definitions of "Research"

Data presented in this paper may or may not use the same definitions for "research," "basic research," "applied research," "development," and "management of R & D," from one source to another. Further, available information comes from different sources - e.g. individual scientists and engineers, academic departments or employers - and is not, therefore, strictly comparable. For purposes of this paper, no attempt has been made to differentiate definitions in one questionnaire from those in another or to indicate those where no definition is given. The words regarding research have been assumed to have common definitions, commonly understood and accepted by employers of scientists and engineers, by scientists and engineers themselves, and by the readers of this paper. To have taken any one set of definitions from any single data source and been bound by them would have made comparison with other data impossible.

Organization of the Study

This paper will examine some of the findings of pertinent reports, indicating the nature of the "jigsaw puzzles" and the kinds of assumptions that are made to provide some delineation of the characteristics of women scientists and engineers performing research. It then looks specifically at data on women employed in academic institutions, and in industry, with some sample data about women employed in government. A short section on minority women indicates how small a group this is and how little is known about these women relative to others.

Some changes over time are shown for the periods where comparable data exist, including a discussion of salaries as a fringe indicator of the status of women scientists and engineers.

Available data on the labor force participation of women scientists and engineers is examined and questioned, and findings are summarized beginning on page 34.

The tables in this report include both numbers and percentages of women in various facets of science and engineering shown over time, because in some instances the numbers are essential to indicate how small and thus how unreliable some of the data cells are. The interpretation of the tables is in the text.

Recommendations regarding future data collection are incorporated at the end of the summary of findings.

WOMEN IN RESEARCH

Overview

The number of women scientists and engineers employed in research and development is only a small fraction (less than 6%) of the total 542,000 scientists and engineers so employed in 1977.[1] Very little information exists on women employed in research below the doctorate level, although the available data indicate that the proportion of all women scientists and engineers who list their principal work activity as research is generally comparable to the proportion of men who make that indication.

Within the National Sample of Scientists and Engineers surveyed in 1974, only 5% are women.[2] This sample is derived from the 1970 Census and therefore includes only persons who were already employed before 1970. It includes scientists and engineers at all degree levels, and no cross tabulations by sex and degree level are available.

Among scientists and engineers in this sample whose primary work activity was basic or applied research, 9.6% were women,[3] a higher proportion than their proportion in the National Sample (Table 1). However, 30% of men and only 25% of women scientists and engineers were engaged in R & D, with the proportions highest in the physical and environmental sciences and lowest in the social sciences, psychology and computer sciences. The proportion varied from less than one percent of all researchers in engineering to 23.1% in psychology.

We cannot distinguish the degree level of women working in research from this National Sample, nor can we distinguish differences between men and women working in research by type of employer. (Table 2)

The National Sample is one of three parts of the National Science Foundation's Manpower Characteristics System (MCS), where data are pulled together in even-numbered years from a combination of the National Sample, a survey of New Entrants since 1970, and some input of new doctorates from the Doctorate Roster. Table 1 shows the number of men and women scientists and engineers in the National Sample in 1974 and the number of each who were working in research. Table 3 shows the number of men and women scientists and engineers in the Manpower Characteristics System and the number who were working in research in 1974.[4] The proportion of women among employed scientists and engineers is higher in the MCS (5.8%) than in the National Sample (4.3%) and the proportion of basic and applied researchers who are women also is higher (13.7% and 8.3%). Both of these data sets include persons at all degree levels, and both sets indicate that women are proportionately more likely than men to be working in basic or applied research and less likely to be in development, with some exceptions by field, as in the life sciences.

TABLE 1

NUMBER AND PROPORTION OF SCIENTISTS AND ENGINEERS IN THE NATIONAL SAMPLE WHO WERE WORKING IN RESEARCH 1974, BY FIELD AND SEX

Total All Fields	Total Scientist & Engineers				In Research and Development											
					Total				In Basic Research				In Applied Research			
	Men	% of Total	Women	% of Total	Men	% of Men	Women	% of Women	Men	% of Men	Women	% of Women	Men	% of Men	Women	% of Women
All Fields	969,674	95.7	43,412	4.3	291,931	30.1	10,845	25.0	35,325	3.6	5,904	13.6	50,677	5.2	3,249	7.5
Phys. Sci.	104,954	93.6	7,125	6.4	45,603	43.5	3,845	54.0	16,562	15.8	2,266	31.8	15,423	14.7	1,162	16.3
Math. Sci.	22,717	88.0	3,099	12.0	2,948	13.0	336	10.8	1,427	6.3	225	7.3	1,089	4.8	93	3.0
Computer Sci.	47,501	89.5	5,581	10.5	2,883	6.1	253	4.5	169	0.4	75	1.3	374	0.8	32	0.6
Environ. Sci.	27,111	97.1	815	2.9	6,893	25.4	514	63.1	2,492	9.2	314	38.5	3,577	13.2	184	22.6
Engineers	645,168	99.6	2,599	0.4	210,636	32.6	1,122	43.2	3,843	0.6	36	1.4	19,890	3.1	286	11.0
Life Sci.	62,008	88.6	7,950	11.4	16,433	26.5	2,994	37.7	8,133	13.1	2,152	27.1	6,936	11.2	731	9.2
Psychology	24,354	74.2	8,465	25.8	2,279	9.4	685	8.1	921	3.8	357	4.2	1,010	4.1	224	2.6
Social Sci.	35,861	82.2	7,778	17.8	4,256	11.9	1,096	14.1	1,656	4.6	479	6.2	2,378	6.6	537	6.9

SOURCE: Characteristics of the National Sample of Scientists and Engineers - 1974, Part 2, Employment, NSF 76-323

TABLE 2

NUMBER AND PROPORTION OF SCIENTISTS AND ENGINEERS IN THE NATIONAL SAMPLE WHO WERE WORKING IN RESEARCH IN 1974, BY TYPE OF EMPLOYER

Total All Fields	Total in R&D	TYPE OF EMPLOYER															
		Business, Industry		Educational Institutions						Hospitals & Clinics		Non-Profit Orgs.		Federal Government		Other Government	
				Total		Univ. & Colleges		Other									
All Fields	302,776	185,669	61.3	27,286	9.0	26,604	8.8	682	0.2	1,743	0.6	10,785	3.6	31,302	10.3	18,655	6.1
Phys. Sci.	49,448	20,841	42.1	9,154	18.5	9,019	18.2	135	0.3	618	1.2	2,910	5.9	6,572	13.3	1,807	3.6
Math. Sci.	3,284	342	10.4	1,284	39.1	1,284	39.1	-	-	-	-	203	6.2	738	23.8	231	7.0
Computer Sci.	3,136	2,234	71.2	206	6.6	206	6.6	-	-	-	-	48	1.5	116	3.7	290	9.2
Environ, Sci.	7,407	2,386	32.2	1,487	20.1	1,387	18.7	100	1.4	-	-	105	1.4	1,946	26.3	811	10.9
Engineers	211,758	157,186	74.2	3,565	1.7	3,381	1.6	184	-	-	-	5,238	2.5	16,413	7.8	12,813	6.1
Life Sci.	19,427	2,014	10.4	8,644	44.5	8,489	43.7	155	0.8	835	4.3	957	4.9	3,807	19.6	1,714	8.8
Psychology	2,964	313	10.6	1,051	35.5	1,012	34.1	39	1.3	290	9.8	573	19.3	417	14.1	183	6.2
Social Sci.	5,352	353	6.6	1,895	35.4	1,826	34.1	69	1.3	-	-	751	14.0	1,293	24.2	814	15.2

SOURCE: Characteristics of the National Sample of Scientists and Engineers - 1974, Part 2, Employment, NSF 76-323

TABLE 3

NUMBER AND PROPORTION OF SCIENTISTS AND ENGINEERS IN THE MANPOWER CHARACTERISTICS SYSTEM WHO WERE WORKING IN RESEARCH IN 1974, BY FIELD AND SEX

Total All Fields	Total Number				In Research and Development											
					Total				In Basic Research				In Applied Research			
	Men	% of Total	Women	% of Total	Men	% of Men	Women	% of Women	Men	% of Men	Women	% of Women	Men	% of Men	Women	% of Women
All Fields	1,556,100	94.2	96,000	5.8	447,200	30.7	23,500	24.5	49,800	3.2	7,900	8.2	83,300	5.3	7,500	7.8
Phys. Sci.	141,200	90.7	14,400	9.3	59,200	41.9	6,400	44.3	19,000	13.5	2,800	19.4	19,800	14.0	1,700	11.8
Math. Sci.	37,900	84.6	6,900	15.4	5,900	15.6	900	13.0	2,200	5.8	300	4.3	1,900	5.0	300	4.3
Comp. Spec.	100,800	82.7	21,100	17.3	8,700	8.6	1,000	4.7	1,200	1.2	200	0.9	1,900	1.9	200	0.9
Environ. Sci.	42,300	95.9	1,800	4.1	11,100	26.2	800	44.4	4,000	9.5	500	27.8	5,600	13.2	300	16.7
Engineers	993,500	99.5	5,200	0.5	333,200	33.5	1,800	34.6	5,200	0.5	100	1.9	31,700	3.2	400	7.7
Life Sci.	117,600	86.5	18,300	13.5	33,600	28.6	7,600	41.5	11,900	10.2	2,800	15.3	13,400	11.4	2,500	13.7
Psych.	46,400	75.6	15,000	24.4	6,700	14.4	2,500	16.7	2,100	4.5	600	4.0	2,200	4.7	800	5.3
Social Sci.	86,600	86.8	13,200	13.2	18,800	21.7	2,600	19.7	1,300	5.0	600	4.5	6,800	7.8	1,300	9.8

SOURCE: U.S. Scientists and Engineers, 1974, NSF 76-329

The National Sample does not include any women who entered the labor force after 1970, and the Manpower Characteristics System has added mostly women at the baccalaureate level who graduated after that date. Because the proportion of women receiving advanced degrees in science and engineering has climbed rapidly during the decade of the seventies, neither the data from the National Sample or from the Manpower Characteristics System in 1974 are as likely to show the picture in 1977 as are studies of doctorate scientists and engineers in 1975.

Doctoral Scientists and Engineers

Although persons holding a doctorate degree make up only one-fifth of the total research manpower, both better and later data are available on doctoral women scientists and engineers than on all women scientists and engineers.

Among all working scientists and engineers in 1974, 7% of men and 15% of women list teaching as their primary activity, while 8.6% of men and 16% of women indicate that their primary activity is in the area of basic or applied research.[5]

Among all doctoral scientists and engineers, about 39,100 were employed in basic research, 33,780 in applied research, 11,600 in development, and 36,815 in the management of R & D in 1975.[6] Only 2.5% of those in the management level are women. The doctorate group makes up about one-fifth of all scientists and engineers employed in research and development and R & D engaged the services of about two-fifths of the total 278,000 doctorate scientists and engineers in 1975.

Among all doctoral scientists and engineers employed in research and development, about 40% are employed in private industry, 37% in academic institutions and 14% in the federal government.[7]

As shown in Table 4, women doctoral scientists and engineers are more likely than men to work in educational institutions, hospitals and clinics, and non-profit organizations; and less likely to be employed in business and industry or in government.[8]

TABLE 4

PROPORTION OF ALL DOCTORAL SCIENTISTS AND ENGINEERS AND WOMEN DOCTORAL SCIENTISTS AND ENGINEERS IN VARIOUS EMPLOYMENT SETTINGS, 1975

	ALL	WOMEN
Number	262,062	22,386
Business & Industry	25.1%	9.7%
Educational Institutions	58.5	70.3
Colleges and Universities	(56.3)	(64.4)
Two Year Colleges	(1.4)	(3.2)
Elementary/Secondary Schools	(0.7)	(2.7)
Hospitals & Clinics	2.9	7.9
Non Profit Organizations	3.2	4.1
Federal Government	8.3	4.7
Other Government	2.0	1.8

SOURCE: National Science Foundation, NSF 77-309.

We have no data to tell us what proportion of women were working in research within each of these various employment settings or whether the proportions for women are different than for men. We can see that the employment setting of men and women doctorates is significantly different.

There is no substantial difference by field in employer categories of women except in psychology, where only 58% work in educational institutions, and 20% are employed in hospitals and clinics.

Among employed doctoral scientists and engineers in 1975, 26.7% of women and 28.6% of men list basic or applied research as their primary work activity, down slightly from 27.0% and 29% in 1973. (Table 5). An additional 14.3% (15.1% of employed men and 6.1% of employed women) report that they are primarily administrators of research and development.[9] As can be seen in Table 5, doctoral women appear somewhat more likely than men to be working in basic research and somewhat less likely than men to be working in applied research. This is true when all fields are combined, and holds true in the physical sciences, computer sciences, environmental sciences, the life sciences, and the social sciences. In psychology, approximately equal proportions of men and of women are working in both basic and applied research

TABLE 5

NUMBER AND PERCENT OF EMPLOYED DOCTORATES REPORTING WORK ACTIVITY WHO ARE WORKING IN RESEARCH AND DEVELOPMENT, BASIC AND APPLIED RESEARCH 1973 & 1975, BY SEX

Total All Fields	Total Number				RESEARCH AND DEVELOPMENT											
					Total				In Basic Research				In Applied Research			
	Men	% of Total	Women	% of Total	Men	% of Men	Women	% of Women	Men	% of Men	Women	% of Women	Men	% of Men	Women	% of Women
All Fields																
1973	194,660	92.3	16,180	7.7	64,992	33.4	4,517	27.9	28,872	14.8	3,403	21.0	27,683	14.2	971	6.0
1975	234,375	91.5	21,808	8.5	78,468	33.5	6.042	27.7	34,624	14.8	4,497	20.6	32,458	13.8	1,321	6.1
Phys. Sci.																
1973	44,579	96.2	1,770	3.8	19,145	42,9	594	33.6	9,083	20.4	328	18.5	8,334	18.7	193	10.9
1975	51,969	95.5	2,448	4.5	22,180	42.7	978	40.0	10,485	20.2	659	26.9	9,591	18.5	265	10.8
Math Sci.																
1973	11,122	93.5	778	6.5	2,349	21.1	69	8.9	1,372	12.3	41	5.3	813	7.3	23	3.0
1975	12,805	93.5	894	6.5	2,673	20.9	93	10.4	1,526	11.9	67	7.5	819	6.4	21	2.3
Computer Sci.																
1973	2,727	97.1	80	2.9	1,003	36.8	40	50.0	191	7.0	3	3.8	276	10.1	14	17.5
1975	3,472	96.2	136	3.8	1,404	40.4	72	52.9	225	6.5	11	8.1	360	10.4	17	12.5
Environ. Sci.																
1973	9,538	97.4	253	2.6	3,393	35.6	118	46.6	1,844	19.3	95	37.6	1,388	14.6	23	9.1
1975	11,783	97.2	343	2.8	4,563	38.7	122	35.6	2,229	18.9	89	25.9	2,155	18.3	28	8.2
Engineers																
1973	34,181	99.6	133	0.4	13,129	38.4	55	41.3	1,053	3.1	9	6.8	7,020	20.5	30	22.6
1975	42,403	99.4	239	0.6	16,715	39.4	118	49.4	1,634	3.9	27	11.3	8,141	19.2	48	20.1
Life Sci.																
1973	48,262	89.5	5,687	10.5	20,144	41.7	2,751	48.4	12,603	26.1	2,367	41.6	7,080	14.7	365	6.4
1975	57,736	88.6	7,399	11.4	23,860	41.3	3,415	46.2	15,079	26.1	2,932	39.6	8,124	14.1	449	6.1
Psychology																
1973	19,076	80.5	4,622	19.5	2,505	13.1	491	10.6	1,365	7.2	295	6.4	994	5.2	162	3.5
1975	23,382	78.8	6,279	21.2	2,811	12.0	675	10.8	1,496	6.4	397	6.3	1,108	4.7	247	3.9
Social Sci.																
1973	25,073	89.8	2,850	10.2	3,324	13.3	397	13.9	1,415	5.6	211	7.4	1,778	7.1	159	5.6
1975	30,762	88.3	4,062	11.7	2,811	9.1	675	16.6	1,496	4.9	397	9.8	1,108	3.6	247	6.1

Source: Characteristics of Doctoral Scientists and Engineers in the U.S., 1975, NSF 77-309
Characteristics of Doctoral Scientists and Engineers in the U.S., 1973, Detailed Statistical Tables, NSF 75-312A

and in the mathematical sciences, a higher proportion of men than of women are engaged in both basic and applied research. There are few women engineers, and statistics on their research participation probably are not as significant as in other fields where they make up a higher proportion of the total.

The number of doctoral women scientists and engineers as well as the number and the proportion of women among those working in the areas of research is shown by field in Table 6 for 1973 and in Table 7 for 1975. Their proportion of the total climbed from 8.7% to 9.4% in those two years and their proportion of doctorate researchers also increased from 7.2% to 8.0% although it remains below their proportion in the total doctoral population. This is largely accounted for by the slightly larger proportion of women than men who were out of the labor force in each of these years. Table 5 deals with similar data but includes only employed scientists and engineers in the totals, and indicates the proportionate segment of each sex engaged in research.

According to the 1975 survey of a sample of all U.S. doctorates, newer graduates are more likely than those from earlier years to be working in research. For the survey in 1975, 30% of all doctoral recipients from 1974 compared to only 25% of those from all earlier years were principally doing research in 1975.[10] This may result from the higher proportion holding postdoctorate appointments a year after receipt of the doctorate.

EMPLOYMENT SETTINGS

Research in Academic Institutions

More than half (53%) of the U.S. basic research effort is performed in academic institutions, and this level has been relatively constant over the past six years.[11] In January 1976, 230,500 scientists and engineers were employed full-time at colleges and universities, up from 224,800 a year earlier. The 35,900 women in this group are 15.6% of the total. Available data show that 44,549 of these academically employed

TABLE 6

DOCTORAL SCIENTISTS AND ENGINEERS IN RESEARCH, BY SEX AND FIELD, 1973

FIELD	Total			Research & Development								
				Total			Basic			Applied		
	All	Women	%	All	Women	% W	All	Women	% W	All	Women	% W
All Fields	244,921	21,261	8.7	69,509	4,517	6.5	32,275	3,403	10.5	28,654	971	3.4
Physical Sci.	53,425	2,486	4.7	19,739	594	3.0	9,411	382	4.1	8,527	193	2.3
Chemists	33,881	1,950	5.8	11,434	431	3.8	4,647	262	5.6	5,563	154	2.8
Physicists	19,544	536	2.7	8,305	163	2.0	4,763	120	2.5	2,964	39	1.3
Math. Sci.	13,515	992	7.3	2,418	69	2.9	1,413	41	2.9	836	23	2.8
Math.	11,984	915	7.6	2,122	51	2.4	1,310	32	2.4	671	15	2.2
Stat.	1,531	77	5.0	296	18	6.1	103	9	8.7	165	8	4.8
Computer	2,943	90	3.1	1,043	40	3.8	194	3	1.5	290	14	4.8
Environ. Sci.	11,074	307	2.8	3,511	118	3.4	1,939	95	4.9	1,411	23	1.6
Earth Sci.	9,142	236	2.6	2,697	81	3.0	1,379	70	5.1	1,175	11	0.9
Ocean.	1,227	54	4.4	502	25	5.0	381	18	4.7	113	7	6.2
Atmos. Sci.	705	17	2.4	312	12	3.8	179	7	3.9	123	5	4.1
Engineers	37,569	165	0.4	13,184	55	0.4	1,062	9	0.8	7,050	30	0.4
Life Sci.	64,540	7,697	11.9	22,895	2,751	12.0	14,970	2,367	15.8	7,445	365	4.9
Biologists	41,035	6,214	15.1	15,439	2,295	14.9	12,066	2,059	17.1	3,195	223	7.0
Agri. Sci.	11,893	175	1.5	4,451	63	1.4	983	22	2.2	3,326	38	1.1
Medical Sci.	11,612	1,308	11.3	3,005	393	13.1	1,921	286	14.9	924	104	11.3
Psychologists	28,286	5,777	20.4	2,996	491	16.4	1,660	295	17.8	1,156	162	14.0
Social Sci.	32,773	3,582	10.9	3,721	397	10.7	1,626	211	13.0	1,937	159	8.2
Economists	9,678	610	6.3	1,445	97	6.7	352	36	10.2	1,059	58	5.5
Sociologists/ Anthro.	7,455	1,444	19.4	969	174	18.0	608	111	18.3	310	55	17.7
Other	15,640	1,528	10.1	1,307	126	9.6	666	64	9.6	568	46	8.1
No Report	796	165	20.7	2	2	100	-	-	-	2	2	100

SOURCE: National Science Foundation, NSF 76-312-A.

TABLE 7

DOCTORAL SCIENTISTS AND ENGINEERS IN RESEARCH, BY SEX AND FIELD, 1975

FIELD	Total			Research & Development								
				Total			Basic			Applied		
	All	Women	%	All	Women	% W	All	Women	% W	All	Women	% W
Total	227,517	26,118	9.4	84,510	6,042	7.1	39,121	4,497	11.5	33,779	1,321	3.9
Physical Sci.	59,267	3,097	5.2	23,158	978	4.2	11,144	659	6.0	9,856	265	2.7
Chemists	38,784	2,502	6.5	14,003	775	5.5	6,158	514	8.3	6,359	218	3.4
Physicists	20,483	595	2.9	9,155	203	2.2	4.986	145	2.9	3,497	47	1.3
Math. Sci.	14,542	1,047	7.2	2,766	93	3.4	1,593	67	4.2	840	21	2.5
Math.	12,729	955	7.5	2,383	79	3.3	1,468	59	4.0	633	15	2.4
Stat.	1,813	92	5.1	383	14	3.6	125	8	6.4	207	6	2.9
Computer Spec.	3,662	147	4.0	1,476	72	4.9	236	11	4.7	377	17	4.5
Environ. Sci.	12,783	379	3.0	4,685	122	2.6	2,318	89	3.8	2,183	28	1.3
Earth Sci.	10,076	279	2.8	3,138	69	2.2	1,352	49	3.6	1,669	18	1.1
Ocean	1,353	67	5.0	640	28	4.4	516	26	5.0	120	2	1.7
Atmos. Sci.	1,354	33	2.4	907	25	2.7	450	14	3.1	394	8	2.0
Engineers	44,425	288	0.6	16,833	118	0.7	1,661	27	1.6	8,189	48	0.6
Life Sci.	72,316	9,176	12.7	27,275	3,415	12.5	18,011	2,932	16.3	8,573	449	5.2
Biologists	43,754	7,225	16.5	17,352	2,827	16.3	14,074	2,540	18.0	3,022	265	8.8
Agri. Sci.	14,277	214	1.5	5,865	79	1.3	1,323	24	1.8	4,312	48	1.1
Medical Sci.	14,285	1,737	12.2	4,058	509	12.6	2,614	368	14.1	1,239	136	11.0
Psychologists	31,613	7,043	22.3	3,486	675	19.4	1,893	397	21.0	1,355	247	18.2
Social Sci.	38,251	4,762	12.5	4,827	567	11.7	2,263	313	13.8	2,406	246	10.2
Economists	11,049	720	6.5	1,740	139	8.0	530	34	6.4	1,194	103	8.6
Sociologists/ Anthro.	8,775	1,960	22.3	1,201	247	20.6	721	151	20.9	480	96	20.0
Other	18,427	2,082	11.3	1,886	181	10.0	1,012	128	12.6	732	47	6.4
No Report	658	179	27.2	4	2	50.0	2	2	100	-	-	-

SOURCE: National Science Foundation, NSF 77-309.

scientists and engineers (19%) are engaged principally in research and development but do not tell us whether that proportion is different for women than for men.[12]

Graduate students are a significant fraction of the scientific and engineering research work force in academic institutions, making up 44% of the total numbers in the academic research work force in January 1976.[13] (Tables 8 and 9). Their proportion of the total effort in time is, of course, much less because they are working only part-time in research. By field, proportionately more students than faculty were performing research in engineering, physical and environmental sciences, social sciences and psychology with proportionately fewer in the mathematical and life sciences. Unfortunately, these data are not available by sex.

In 1975, there were 52,600 women enrolled full-time in graduate science departments[14] in a total full-time graduate enrollment of 210,700 full-time science and engineering students, making women only about one-fourth of the total of all graduate students in science and engineering. Whether women, in the same proportion as men, have research assistantships or are otherwise primarily involved in research, we do not know, since the available statistics do not provide these data by sex. In 1976, 40,200 graduate students were employed part-time in research and development.[15] We do not have this number broken out by sex.

Among the 17,100 post-doctorates appointed in science departments in 1975 (up three percent over 1974),[16] the proportion of women also is not known. However, in fiscal year 1976, 26.5% of new male science doctorate awardees that year indicated plans for postdoctoral appointments as did 27.4% of women in these fields.[17] An equal proportion (about 20% of each sex) already had located such appointments by the time their Ph.D. was received. Thus, we might assume that the proportion of women in postdoctoral positions among all fairly new doctorates is not significantly different from that of men. Since women earned 14% of science and engineering doctorates in 1974[18], we might assume that about 14% of these postdoctoral appointees (about 2,400)

TABLE 8

Number of scientists and engineers primarily engaged in research and development in universities and colleges by field of specialization: January of selected years[1]

[In thousands]

Field of specialization	1965	1969	1971	1973	1974	1975	1976
All fields	40.0	47.1	48.3	46.6	47.4	50.0	51.0
Engineering	4.2	5.0	4.8	5.0	4.9	4.8	4.7
Physical and environmental sciences	5.9	7.0	7.3	7.9	8.3	8.1	8.6
Chemistry	2.3	2.9	2.6	2.8	3.0	2.8	2.9
Physics	2.1	2.4	2.4	2.5	2.5	2.4	2.4
Other	1.5	1.9	2.3	2.7	2.8	2.9	3.2
Mathematics	.9	1.7	1.4	1.3	1.5	1.5	1.6
Life sciences	25.0	28.3	30.4	28.0	28.0	30.6	30.8
Social sciences and psychology[2]	4.0	5.2	4.2	4.4	4.7	5.0	5.3

[1] Excludes graduate students
[2] Excludes history

NOTE: Components may not add to totals because of independent rounding
SOURCE: National Science Foundation, NSF 77-310

TABLE 9

Number of graduate students engaged part time in research and development by field of specilization: January of selected years[1]

[In thousands]

Field of specialization	1965	1969	1971	1973	1974	1975	1976
All fields	27.2	35.8	37.2	34.6	36.9	39.7	40.2
Engineering	6.4	7.9	8.9	8.4	9.4	11.1	11.0
Physical and environmental sciences	8.1	10.6	10.5	8.8	9.2	9.0	9.2
Mathematics	.9	1.6	1.5	1.5	1.5	1.4	1.3
Life sciences	8.5	10.0	11.2	10.5	10.7	10.8	11.4
Social sciences and psychology[2]	3.3	5.7	5.1	5.4	6.2	7.4	7.3

[1] Based on data obtained in the NSF Survey of Scientific and Engineering Personnel Employed at Universities and Colleges for 1965-74 and the Survey of Graduate Science Student Support and Postdoctorals for the years 1975-76. See technical notes
[2] Excludes history

NOTE: Components may not add to totals because of independent rounding
SOURCE: National Science Foundation, NSF 77-310

were women, and that perhaps a third of them were engaged in research.

Expenditures for research and development are highly concentrated in a few universities. The leading 20 universities in separately funded R & D expenditures accounted for 36% of total R & D spending in 1977, and this shows little change since 1970.[19] The proportion of women among full-time employed scientists and engineers in the top 19 institutions in R & D expenditures is shown in Table 10.

TABLE 10

NUMBER AND PERCENT OF WOMEN SCIENTISTS AND ENGINEERS (AS OF JANUARY, 1976) IN NINETEEN UNIVERSITIES REPORTING LARGEST AMOUNT OF SEPARATELY FUNDED R & D EXPENDITURES 1975-76

UNIVERSITY	TOTAL	WOMEN	% WOMEN
1. U. Wisconsin - Madison	2,658	624	23.5
2. Mass. Inst. of Tech.	1,807	234	12.9
3. U.C. - San Diego	880	85	9.7
4. U. Michigan	3,041	732	24.1
5. U. Minnesota	2,801	456	16.3
6. Stanford	1,717	305	17.7
7. U. Washington	2,146	564	26.3
8. U.C. Berkeley	1,368	165	12.1
9. Columbia	1,289	250	19.4
10. Cornell	2,020	325	16.1
11. Harvard	3,090	429	13.9
12. U.C. - Los Angeles	1,518	195	12.8
13. U. Chicago	1,355	247	18.2
14. U. Pennsylvania	1,298*	208*	16.0
15. Johns Hopkins	1,929	288	14.9
16. U. Illinois - Urbana	2,041	423	20.7
17. U.C. - San Francisco	914	233	25.5
18. Texas A & M	1,757	57	3.2
19. U. Texas - Austin	1,603	307	19.2
TOTAL, 19 Institutions	35,232	6,127	17.4

*January 1975
Source: National Science Foundation, NSF 76-328 and NSF 77-314

While the proportion of women among scientists and engineers in these schools ranges from 3.2% at Texas A & M to 26.3% at the University of Washington, the proportion of women among all full-time scientists and engineers reported by these combined

institutions is a surprising 17.4%, a proportion higher than women's share of earned science and engineering Ph.D.'s during the period from 1950 to 1976 (10%) shown in Table 11 by field; higher than the proportion of women among scientists and engineers in the leading 50 institutions in R & D expenditures; and higher than the proportion among scientists and engineers in all doctorate universities as of January 1976 (14.9%) as shown in Table 12.

The proportion of women among scientists and engineers employed at colleges and universities has increased in every field between 1974 and 1976 as shown in Tables 13 and 14. Table 13 includes only the leading 20 doctorate-granting universities in employment of scientists and engineers while Table 14 includes all two-year and four-year colleges and universities.

An interesting finding is that women make up a larger proportion of total science and engineering employment in the largest universities in employment of scientists and engineers than in all universities as a whole (Table 13), and that their proportion in doctorate granting universities is higher than in colleges and universities combined (Table 14). Further, when the leading 10, 20 and 50 institutions in employment of scientists and engineers are examined separately by type of institution (Table 15) we find a higher proportion of women at institutions employing the largest numbers of scientists and engineers than in all institutions of the same type at all public and all private institutions, and at doctorate granting institutions. On the other hand, at institutions granting a master's or a bachelor's degree as the highest degree, the proportion of women is less at the schools employing the most scientists and engineers. This is readily explained at the bachelor's level when we note that the U.S. Naval and Military academies rank first and second in employment of scientists and engineers, and include only 1% women in this employment.

TABLE 11

NUMBER AND PERCENT OF DOCTORAL DEGREES GRANTED TO WOMEN, BY FIELD AND DECADE, 1920-1975

	Decade													
	1920-29		1930-39		1940-49		1950-59		1960-69		1970-76		1920-76 TOTAL	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
PHYSICAL SCIENCES	247	7.6	442	6.6	406	5.0	685	3.7	1577	4.6	2,579	7.3	5936	5.5
Math	51	14.5	115	14.8	89	10.7	113	5.0	364	5.7	726	8.8	1458	7.7
Physics & Astron.	39	5.9	51	3.8	62	4.2	98	2.0	213	2.2	384	3.7	847	3.0
Chemistry	141	7.3	254	6.4	223	4.2	443	4.4	931	6.4	1,292	9.6	3284	6.6
Earth Sciences	16	4.8	22	3.5	32	5.7	31	1.9	69	2.0	177	4.5	347	3.3
ENGINEERING	2	.9	6	.7	7	.5	20	.3	77	.4	234	1.1	346	0.6
LIFE SCIENCES	378	15.9	765	15.1	738	12.7	1318	9.1	3078	11.6	5,692	16.4	11969	13.5
Biological	341	19.5	698	17.8	699	15.7	1174	11.8	2739	15.1	4,635	20.2	10286	16.8
Agricultural	8	2.2	11	1.6	5	.6	36	1.1	80	1.4	272	3.8	412	2.1
Medical	29	10.9	56	12.4	34	6.9	108	8.1	259	9.5	731	18.1	1217	13.1
SOCIAL SCIENCES	325	17.1	562	15.8	580	14.5	1510	11.0	3604	14.3	8,710	21.6	15291	17.3
Anthropology	8	22.2	28	22.4	22	15.2	90	19.3	218	21.5	983	44.0	1073	26.8
Sociology	32	15.4	89	19.9	99	17.2	221	14.2	442	17.5	1,115	26.1	1998	20.6
Economics	52	8.5	71	6.4	83	7.1	125	4.2	245	4.6	468	7.9	1044	6.1
Pol. Sci. & Pub. Adm.	26	9.0	45	8.5	45	7.8	87	5.4	257	8.2	677	13.3	1137	10.2
Psychology	189	29.4	290	26.0	302	24.1	911	14.8	2264	20.7	4,900	29.0	8856	23.9
ARTS & HUMANITIES	619	25.7	1291	24.5	1182	22.9	1758	15.5	4423	19.5	9,777	29.1	19050	23.6
History	143	21.6	277	19.3	237	16.6	327	10.4	638	11.3	1,057	13.3	2953	14.5
Eng. & Am. Lit.	159	30.8	385	28.4	385	26.8	548	17.8	1515	23.9	3,266	36.4	6258	28.9
Modern Foreign Lang.	101	29.8	287	27.0	284	29.2	396	22.9	1032	31.2	2,317	43.6	4417	34.6
PROF. FIELDS	38	6.9	78	7.7	113	9.6	249	9.2	798	12.3	1,391	14.0	2667	12.2
Business Adm.	-	-	2	1.0	14	6.3	32	3.4	77	2.6	168	3.3	293	3.1
Law, Jurisprudence	9	3.9	14	4.7	7	6.3	14	4.7	6	2.2	11	5.3	61	4.3
Library Sciences	-	-	8	33.3	15	34.1	18	28.6	43	27.0	147	38.4	231	34.3
Social Work	-	-	1	50.0	3	50.0	26	41.3	180	36.7	284	33.7	494	35.2
EDUCATION	209	18.1	615	19.7	1086	22.8	2431	18.0	5367	19.5	12,722	26.3	22430	22.7
TOTAL ALL FIELDS	1826	15.3	3784	14.8	4115	13.5	7972	9.9	18964	11.7	41,200	18.2	77861	14.5

SOURCE: Doctorate Records File, National Research Council

TABLE 12

PROPORTION OF WOMEN AMONG FULL TIME SCIENTISTS AND ENGINEERS AT TWENTY AND FIFTY LEADING DOCTORATE GRANTING INSTITUTIONS IN EMPLOYMENT OF SCIENTISTS AND ENGINEERS AND AT ALL DOCTORATE GRANTING INSTITUTIONS, BY FIELD, JANUARY 1976

FIELD	20 LEADING INSTITUTIONS			50 LEADING INSTITUTIONS			ALL INSTITUTIONS		
	TOTAL	WOMEN	% WOMEN	TOTAL	WOMEN	% WOMEN	TOTAL	WOMEN	% WOMEN
TOTAL, ALL S/E FIELDS	40,993	7,316	17.9	75,435	12,040	16.0	154,208	22,940	14.9
ENGINEERING	4,830	210	4.3	8,302	261	3.1	16,864	372	2.2
PHYSICAL SCIENCES	3,564	255	7.2	6,975	417	6.0	15,498	944	6.1
ENVIRONMENTAL SCIENCES	1,236	87	7.0	2,333	139	6.0	4,764	243	5.1
MATHEMATICAL SCIENCES	2,069	210	10.1	4,153	394	9.5	10,393	1,050	10.1
LIFE SCIENCES	22,876	5,180	22.6	40,829	8,338	20.4	77,948	15,018	19.3
PSYCHOLOGY	1,488	418	28.1	3,047	763	25.0	7,479	1,617	21.6
SOCIAL SCIENCES	4,924	956	19.4	9,796	1,728	17.6	21,262	3,696	17.4

TABLE 13

PROPORTION OF WOMEN AMONG FULL TIME SCIENTISTS AND ENGINEERS AT TWENTY LEADING UNIVERSITIES IN EMPLOYMENT OF SCIENTISTS AND ENGINEERS, BY FIELD AND YEAR, 1974, 1975 AND 1976

FIELD	JANUARY 1974			JANUARY 1975			JANUARY 1976		
	TOTAL	WOMEN	% WOMEN	TOTAL	WOMEN	% WOMEN	TOTAL	WOMEN	% WOMEN
TOTAL, ALL S/E FIELDS	36,653	5,916	16.1	41,187	7,158	17.4	40,993	7,316	17.9
ENGINEERING	3,543	65	1.8	4,825	177	3.7	4,830	210	4.3
PHYSICAL SCIENCES	3,037	144	4.7	3,622	215	5.9	3,564	255	7.2
ENVIRONMENTAL SCIENCES	897	45	5.0	1,160	80	6.9	1,236	87	7.0
MATHEMATICAL SCIENCES	1,715	115	6.7	2,017	186	9.2	2,069	210	10.1
LIFE SCIENCES	21,150	4,526	21.4	22,614	5,190	23.0	22,876	5,180	22.6
PSYCHOLOGY	1,344	266	19.8	1,534	388	25.3	1,488	418	28.1
SOCIAL SCIENCES	4,968	755	15.2	5,415	922	17.0	4,924	956	19.4

Source: National Science Foundation - NSF 74-315, NSF 75-331, NSF 76-328

TABLE 14

FULL-TIME SCIENTISTS AND ENGINEERS EMPLOYED IN UNIVERSITIES AND COLLEGES BY FIELD OF EMPLOYMENT AND SEX: JANUARY 1974-76

Field of Employment	1974			1975			1976		
	Total	Women	% Women	Total	Women	% Women	Total	Women	% Women
Total	218,843	32,442	14.8	224,784	34,133	15.2	230,539	35,929	15.6
Engineers (Total)	22,764	339	1.5	22,579	369	1.6	22,799	447	2.0
Aero. & Astro.	1,023	22	2.1	944	25	2.6	963	28	2.9
Chemical	1,522	22	1.4	1,603	25	1.6	1,622	37	2.3
Civil	3,759	61	1.6	3,830	61	1.6	4,008	83	2.1
Electrical	5,404	57	1.1	5,394	57	1.0	5,393	74	1.4
Mechanical	4,255	33	0.8	4,355	30	0.7	4,351	45	1.0
Other	6,801	144	2.1	6,453	171	2.6	6,462	180	2.8
Physical Sci. (total)	33,412	2,266	6.8	33,479	2,321	6.9	34,442	2,500	7.3
Chemists	14,075	1,385	9.8	13,826	1,431	10.4	14,172	1,521	10.7
Earth	6,563	327	5.0	6,789	320	4.7	7,260	379	5.2
Physicists	10,870	395	3.6	10,941	387	3.5	10,867	402	3.7
Other	1,904	159	8.4	1,923	183	9.5	2,143	198	9.2
Math. Sci. (Total)	22,157	2,822	12.7	22,392	2,925	13.1	23,081	3,093	13.4
Life Sci. (Total)	88,900	18,056	20.3	92,004	18,557	20.2	92,589	18,679	20.2
Agricultural	12,781	1,461	11.4	13,613	1,796	13.2	12,963	1,417	10.9
Biological	31,539	5,735	18.2	33,490	6,374	19.0	34,744	6,987	20.1
Medical	44,580	10,860	24.4	44,901	10,387	23.1	44,882	10,275	22.9
Psychologists (Total)	14,957	3,188	21.3	15,995	3,588	22.4	16,758	3,977	23.7
Social Sci. (Total)	36,653	5,771	15.7	38,335	6,373	16.6	40,870	7,233	17.7
Economists	9,830	788	8.0	10,190	863	8.5	10,410	952	9.1
Sociologists	10,048	2,376	23.6	10,765	2,636	24.5	11,389	2,917	25.6
Political	8,396	863	10.3	8,692	896	10.3	9,027	1,028	11.4
Other	8,379	1,744	20.8	8,688	1,978	22.8	10,044	2,336	23.3

SOURCE: National Science Foundation, NSF 76-321

TABLE 15

NUMBER AND PROPORTION OF WOMEN AMONG FULL TIME SCIENTISTS AND ENGINEERS IN THE LEADING TEN, TWENTY, AND FIFTY INSTITUTIONS IN EMPLOYMENT OF SCIENTISTS AND ENGINEERS, AND IN ALL INSTITUTIONS BY TYPE OF INSTITUTION, JANUARY 1976

Institutions	TOP 10			TOP 20			TOP 50			ALL INSTITUTIONS		
	Total	Women	% W	Total	Women	% W	Total	Women	% W	Total	Women	% W
Public	22,267	4,007	18.0	36,588	6,348	17.3	63,978	9,818	15.3	162,128	24,795	15.3
Private	17,930	3,062	17.1	26,715	4,555	17.1	37,395	5,898	15.8	68,411	11,134	16.3
Doctorate	24,079	4,530	18.8	40,993	7,316	17.8	75,435	12,040	16.0	154,208	22,940	14.9
Master's	3,432	438	12.8	5,664	739	13.0	10,621	1,460	13.7	26,376	3,702	14.0
Bachelor's	1,849	225	12.2	2,833	315	11.1	5,076	682	13.4	23,031	3,798	16.5
2-Year	2,668	641	24.0	4,070	968	23.8	7 145	1,677	23.5	26,424	5,395	20.4
All	40,197	7,069	17.6	63,303	10,904	17.2	101,373	15,716	15.5	230,539	35,929	15.6

Source: National Science Foundation, NSF 76-321

At two-year institutions, the proportion of women among full-time employed scientists and engineers is significantly higher (20.4%) than at doctorate granting institutions (15%), but even here, the proportion is highest at the schools of this group that employ the most scientists and engineers.

This finding, that except for master's and bachelor's institutions, a higher proportion of women are in the science and engineering population in the schools of each category employing the largest numbers of scientists and engineers, might seem to indicate that women are making better progress in the leading institutions in research than in the less research-oriented institutions of each type. However, if this is true, it is equally true that the proportion of women among academically employed scientists and engineers is still highest at two-year institutions even though it is increasing at doctorate granting institutions faster than at those granting only a bachelor's or a master's degree.

Among academically employed scientists and engineers in 1976, 67.5% of men but only 63.8% of women scientists and engineers were employed at doctorate granting institutions; 11.7% of men and 10.3% of women at master's institutions; 9.9% of men and 10.6% of women at bachelor's granting institutions; and 10.8% of men and 15% of women at two-year institutions.[20]

This follows the pattern of faculty employment of women by type of institution, and would seem to indicate that women scientists and engineers, like all women employed in academic institutions, are less likely than men in the same field to be employed by universities and more likely than men to be employed in two and four-year colleges. It may also indicate that a significant fraction of women employed in universities which perform the most research are not faculty members but may be employed on a non-permanent basis as research workers on soft money projects of other faculty members.

Unfortunately, the questionnaires used for these surveys of science and engineering employment at academic institutions do not request any information by sex except an actual "head count" by field. We cannot separate by sex the degree levels of these employees, nor do we know by sex the proportion engaged principally in teaching, in research and development or in something else. We cannot separate by sex the faculty members from the laboratory assistants. We do not know how each institution defines "scientists and engineers." Is the women typist with a bachelor's degree in biology included? Is the total staff in a science department (including secretaries and other staff personnel) counted as scientists in that field? Does the method of counting differ from one institution to the other? We do not know. However, we do know something about these scientists and engineers as a group.

While no information is available by sex, 71.1% of all full-time scientists and engineers employed at colleges and universities in 1976 held a doctorate, 24% had a master's degree and 7.4% a bachelor's degree only.[21] The proportions among women may be different.

No current data are available on faculty by field and sex, nor is the principal activity of scientists and engineers in university employment available by sex. Among all full-time employed scientists and engineers at academic institutions in 1976, 19% are principally in R & D and 75% in teaching. Among those employed part time,

11% are working principally in R & D and 87% are teaching. Data about faculty by field and sex would indicate whether women in science and engineering have different proportional representation on college and university faculties (relative to their share of earned doctorates) than have women in other fields. It also might show whether the proportions of women scientists and engineers in faculty positions in larger, research-oriented universities are different than in smaller or less research-oriented universities or colleges. We do not know how many women scientists and engineers are principally performing research in academic settings. Information from other studies indicates that the proportion of both sexes engaged principally in research is similar, since the proportion of women scientists and engineers listing basic or applied research as their primary activity was similar to the proportion among all doctorates in 1975 (Table 5) and among all scientists and engineers at all degree levels in 1974 (Table 3). However, no data are available to show the nature of their appointments, status or responsibility relative to men.

Although no current data are available to provide us with cross tabulations by sex among academically employed scientists and engineers for academic rank, salary, principal activity, field or other demographic characteristics that would allow comparison of men and women, we have some information of this type for Fall 1972. Among 36,000 full-time employees at academic institutions who were engaged in organized research in the Fall of 1972, 11,000 (30%) were faculty, 1,900 (5%) were teaching or research assistants and 20,000 (56%) were "other professionals." Among the faculty group, only 13% were women, but 25% of the research and teaching assistants were women and 26% of the "other professionals" were women. [22] The "other professionals" group is not defined.

Research in Industry

Sixty seven percent of the 540,000 R & D scientists and engineers were employed in industry in 1976 - down from 73% in the early sixties.[23] From 1973 to 1975, industrial employment of doctoral scientists and engineers rose 16% to 66,000. The total number of

scientists and engineers grew 13% during this period - from 245,000 to 278,000, with women making up 9.4% of the 1975 doctoral scientists and engineers compared to 8.7% in 1973. In 1975, about 23% of all doctoral scientists and engineers were employed in industry.[24] Among these 65,876 doctorates, 4,322 (6.6%) were primarily in basic research, 15,810 (23.9%) in applied research and 8,795 (5.7%) in management of R & D.

Only 2,172 doctoral women (9.6% of all employed doctoral women) worked in industry,[25] but we have no data by sex correlating work activity and type of employer. Thus, while we do not know whether the proportion of these women performing research in industry is similar to the proportion among all scientists and engineers employed in industry, we do know that women are less likely than men to be employed in industry and that engineers are more likely to be employed in industry than are scientists. When engineers are excluded from the data (since there are few women in the engineering population), we find that among about 218,000 employed doctoral scientists, 43,341 (19.8%) are working in industry. This is more than twice as high a proportion as among women. Within this group of doctoral scientists, 3,941 (9.1%) are in basic research, 10,496 (24%) are in applied research, 3,405 (7.8%) in development and 12,096 (27.9%) in the administration or management of R & D. In all work settings combined, women in almost all science fields appear to be more likely than men to be in basic research, less likely to be in applied research and much less likely to be in development or in management or administration of research (Tables 1 and 3). Whether this holds true in industry is not known.

The 265,000 doctoral scientists and engineers in the labor force in 1975 include 2,500 who were unemployed and seeking jobs. Among those who were employed, 14.1% (20% of women) were engaged in basic research, 12.2% (5.9% of women) in applied research, with an additional 4% (1% of women) working in development and 10.6%

(5.9% of women) being principally engaged as managers or administrators of R & D.[26]

Although data are not available by sex, to correlate work activity with employment setting, the small proportion of all doctoral women scientists and engineers employed in industry, further fragmented by the small proportion engaged in research, indicates that the numbers of these women performing research in an industrial setting must be small, and their proportion of the total undoubtedly smaller than their representation among all doctoral scientists and engineers.

Research in Government

Women scientists and engineers make up varying proportions of persons working in the federal government, according to data for 1975 provided by the Civil Service Commission, ranging from 32.7% of social scientists and psychologists to 1.5% of engineers. (Table 16) These data do not include any information about grade level, work activity, or educational attainment. Civil service information on professional employment in 1973 shows only 1,874 women professionals (6.3% of total 29,533) in the physical sciences; 1,130 (4.5% of total 24,902) in the biological and agricultural sciences; and 3,115 (20.4% of the total 15,280) in the social sciences including psychology.[27] We have no information about the work activity of these women, and do not know what proportion may be involved in research.

A study by Rosalind B. Marimont[28] of women and men employees of the National Institutes of Health found that 1,025 women were 43% of total scientists employed, but the median GS grade for men was GS-14.07 (for a median salary of $24,430) while the women had a median grade of only GS-9.68 with median salary of $12,980.

Among the doctorate staff (Ph.D's and M.D.'s) in 1972, were 66 women and 479 men. The median grade for the 12% who were women was 13.56, while for men it was 14.83. The median salary difference was $4,900 less for women than men. Put another way, women earned only 61% of what men earned, and a woman's chance for a senior

TABLE 16

FULL TIME FEDERAL EMPLOYMENT BY OCCUPATIONAL GROUP AND SEX, 1974-75

ALL AGENCIES — ALL AREAS

OCCUPATIONAL GROUP	EMPLOYMENT 31 OCTOBER 1975 TOTAL	--- WOMEN --- NUMBER	%	EMPLOYMENT 31 OCTOBER 1974 TOTAL	--- WOMEN --- NUMBER	%	PERCENT CHANGE TOTAL	WOMEN
MISC OCCUP	49.147	3.061	6.2	49.018	2.830	5.8	.3	8.2
SOC SCI. PSYCH	48.201	15.754	32.7	44.956	14.068	31.3	7.2	12.0
PERS MGMT	43.830	24.458	55.8	41.810	22.878	54.7	4.8	6.9
GEN ADMIN	472.157	321.359	68.1	473.725	323.369	68.3	- .3	- .6
BIOL SCIENCES	45.615	3.827	8.4	44.476	3.601	8.1	2.6	6.3
ACCT AND BUDGET	119.463	57.282	47.9	118.355	55.802	47.1	.9	2.7
MED. DENT. PH	117.409	69.743	59.4	108.968	65.075	59.7	7.7	7.2
VETERINARY MED	2.828	50	1.8	2.287	47	2.1	23.7	6.4
ENG AND ARCH	151.560	2.288	1.5	146.490	1.990	1.4	3.5	15.0
LEGAL AND KINDRED	58.262	30.623	52.6	55.378	27.943	50.5	5.2	9.6
INFO AND ARTS	20.358	6.560	32.2	19.809	6.200	31.3	2.8	5.8
BUS AND INDUSTRY	69.332	19.378	27.9	67.071	17.681	26.4	3.4	9.6
COPYRIGHT. PAT	1.641	138	8.4	1.666	131	7.9	- 1.5	5.3
PHYSICAL SCI	41.643	3.814	9.2	41.025	3.668	8.9	1.5	4.0
LIBR. ARCHIVE	9.173	5.733	62.5	8.892	5.571	62.7	3.2	2.9
MATH AND STAT	14.226	4.981	35.0	13.805	5.015	36.3	3.0	- .7
EQUIP. FAC. SVC	14.690	393	2.7	15.064	372	2.5	- 2.5	5.6
EDUCATION	28.160	11.345	40.3	26.284	10.145	38.6	7.1	11.8
INVESTIGATION	45.206	2.679	5.9	45.426	2.472	5.4	- .5	8.4
COMM QUAL CONT	18.748	614	3.3	18.643	620	3.3	.6	- 1.0
SUPPLY	62.390	26.877	43.1	62.118	26.282	42.3	.4	2.3
TRANSPORTATION	43.509	6.846	15.7	42.124	6.415	15.2	3.3	6.7
UNSPECIFIED	8.559	1.384	16.2	11.322	2.242	19.8	- 24.4	- 38.3
POSTAL	489.638	77.417	15.8	498.540	78.073	15.7	- 1.8	- .8
TOTAL A/	1.975.745	696.604	35.3	1.957.252	682.490	34.9	.9	2.1

A/ EXCLUDES FOREIGN NATIONALS OVERSEAS.

SOURCE: U.S. Civil Service Commission, Press Release, October 31, 1975

job was only one seventh that of a man. By 1976, her salary was 62% of his, and she still was only one seventh as likely as he to reach senior staff level. Among all scientists (all degree levels) at the National Institutes of Health, women earn 58% of men's salaries, and a man's chance of holding a senior position is five times that of a woman.

LABOR FORCE PARTICIPATION OF WOMEN SCIENTISTS AND ENGINEERS

In 1976 and 1977, the National Science Foundation published two studies on the scientists and engineers in the Manpower Characteristics System, a combination of data from the National Sample (derived from the 1970 Census), surveys of a sample of graduates from 1972 and 1973 (largely at the baccalaureate level), and input of new doctorates from the Doctorate Records File maintained by the National Academy of Sciences.

These reports[29] pointed out an astonishing statistical finding - that 47% of all women scientists and engineers compared to only 12% of men were out of the labor force in 1974, that is, not employed and not seeking employment. A considerable effort has been made by the staff of the Scientific Manpower Commission to determine whether this figure is credible, and if so, why so many women were out of the labor force. A definitive answer is not available, but it appears that this large percentage results from a combination of factors. A large segment of recent baccalaureate graduates probably are full-time graduate students. The MCS sample for women was distorted by the inclusion of relatively many more women from the New Entrants surveys of recent baccalaureate graduates than men, particularly in the social sciences, because the number of women in the National Sample was small. Another contributing factor may be the stated requirements for inclusion or exclusion from the survey sample as they relate to field of degree, field of present work, and self identification There are complex variables which need not be fully identified for purposes of this paper. The most important finding of the effort to delineate the meaning of that

47% figure was that the survey instruments used did not include the right questions to determine why women were out of the workforce in such substantial numbers; and even for those questions which were asked that might have illuminated the finding, the results were never tabulated by sex. Thus, we do not know for sure why this high proportion of women educated in science and engineering were neither working nor seeking work, nor how the proportion would have differed if all the samples used had been over-selected for women in order to provide an adequate base to examine their characteristics. We do know from other data from the Labor Department that among women with four or more years of higher education, 64% are in the labor force,[30] and that among those with five or more years of college, 70% are at work or seeking work in 1974.[31] It seems improbable that women trained in science and engineering would be less likely than women trained in other fields to utilize their training in the labor force.

Among women doctoral scientists and engineers, only 10.6% were out of the labor force in 1975, and half of this group were retired. Only 5.1% of the total were out of the labor force for all reasons other than retirement.[32]

Thus, despite the NSF finding that almost half of all women scientists and engineering were out of the labor force in 1974, the data appear to indicate that a large segment of this group probably were full-time graduate students improving their credentials and training in order to participate later in the labor force.

Among those women who are in the labor force, the unemployment rate is higher than for men. For example, among women doctorates in 1975, 3% of women but only 0.8% of men were unemployed and seeking work. In some fields, the difference in unemployment rates is even higher. Among physicists, 7.3% of women doctorates were unemployed and seeking work in 1975 compared to 1.5% of men. In chemistry, the rates were 3.7% for women and 0.9% for men. In every field, the unemployment rate for women was

at least three times as high for women as for men.[33]

By age, the same unemployment rate difference holds true. Among women aged 30 to 34, 4.6% were unemployed and seeking jobs, as were 0.9% of men in that age. Among those aged 45 to 49, 3.1% of women doctorates and 0.8% of men were in this position.[34]

Among all scientists and engineers in 1974, including persons at all degree levels, 1.8% of women and 0.9% of men were unemployed and seeking work.[35]

Thus, at least some of the women found by the National Science Foundation to be out of the labor force in 1974 are likely to have been discouraged job seekers - and since the unemployment rates for women scientists and engineers are so much higher than for men, women may be more likely than men to be in this category.

A current project now underway by the Scientific Manpower Commission with NSF funding will perform a more detailed analysis of the labor force participation rates of women scientists and engineers in 1976 and 1978, and the factors affecting their participation.

Salaries

While the representational gap between men and women scientists and engineers is decreasing slowly, the salary gap generally is increasing. Women scientists and engineers have lower annual salaries than men at every degree level, every level of experience, in every work setting and in every field, and the salary gap widens with age. Further, this gap is not decreasing. For example, women doctorate scientists in all age groups in 1975 had salaries about 19% below those for men, compared to a 17% difference in 1973, although women doctorates under 30 years of age had 1975 salaries 8% below those for men of the same age with the gap having narrowed from 10% two years earlier.[36]

In 1975, doctoral women scientists and engineers working in basic research had median annual salaries of $18,400 compared to $22,200 for all doctoral scientists and engineers working in basic research. In applied research, the women's figure is $20,400 compared to $23,300 for men and women combined. The data are not available for men only, so that salaries of men and women could be compared directly. However, it is obvious that the salaries of men in each instance would be higher than the combined salaries of men and women, since the data for women show their salaries well below the combined figure.

Women doctoral scientists and engineers with five to nine years of professional experience earned $17,800 in 1975 compared to $19,800 for men and women combined at the same number of years of experience. Even at entry level, the salary gap has not closed. Doctorate women with one or less year of professional experience averaged $15,100 in 1975 compared to all doctoral scientists and engineers at the same experience level who earned $16,200. At 30 to 34 years of experience, the combined group earned a median salary of $29,200 while women doctorates earned only $23,500. In 1973, women doctoral scientists and engineers aged 35 to 39 earned 11% less than men of the same age. In 1975, men in that age group earned 16% more than women.[37]

The salary gap is not limited to women with the doctorate nor is the pattern of change consistent. Women biological and biomedical scientists at the baccalaureate level who were engaged in R & D seven years after receipt of the degree received 28% less than comparable men in 1974. In 1976, only a 20% gap separated men and women at the bachelor's level seven years after the degree. However, among chemists the gap four years after the baccalaureate was 12% in 1974 and had widened to 21% by 1976.[38]

MINORITY WOMEN

Black, American Indian and Asian women are 7% of all women doctorates who identified this characteristic, according to data for 1975 produced by the National

Research Council for NSF. Within the total of 26,118 doctorate women scientists and engineers, NSF says there are 444 black women, 44 American Indians, 1,234 Asians and 23,062 whites. An additional 1,311 doctoral women did not report their racial or ethnic origin for the 1975 survey.[39]

There is no statistical information available on minority women doctorates by primary activity, so we do not know whether they are more or less likely to be working in research than are all women doctorate scientists and engineers.

CHANGES OVER TIME

The number of women choosing to prepare themselves for careers in science and engineering, has been increasing rapidly since the 1950's, but women still constitute less than 10% of all doctoral scientists and engineers in the labor force (Table 7), and their proportion of earned doctorates in the sciences in the first half of the 1970's (13%) is barely above their 12.3% share in the 1920's. (Table 11). Although the actual number of women earning doctorates in the sciences and engineering has increased in every decade of this century, the growth in doctorates for men far surpassed the growth for women, particularly in the decade following World War II. Their proportion is highest among psychologists and lowest among engineers at the doctoral level, and the proportion choosing the social, behavioral and life sciences over the physical sciences and engineering has not altered substantially in fifty years. However, a real change is occurring at the bachelor's level in engineering, where the increase in the number of women freshmen has risen an astonishing 623% from 1969 to 1976. This increase is not yet fully reflected in bachelor's degrees, but the number of women among new baccalaureate engineers has increased 509% in that same time period, from 328 in 1968-69 to 1,376 in 1975-76, and their proportion of the graduates has risen from 0.8% to 3.6%.[40] This increase is expected to continue, at least over the next few years.

Nonetheless, the proportion of women among science and engineering researchers remains small (Tables 3 and 7).

SUMMARY AND RECOMMENDATIONS

1. Among 148,500 scientists and engineers who list basic or applied research as their primary activity in 1974, only 15,400 (10.4%) are women. Among 72,900 doctoral scientists and engineers working principally in basic or applied research in 1975, 5,818 (7.3%) are women.

2. Among all scientists and engineers in 1974, women are more likely than men to work in basic research (8.2% of women and 3.2% of men) and in applied research (7.8% of women and 5.3% of men). However, among science and engineering doctorates in 1975, 20.6% of women and 14.8% of men were working principally in basic research while 6.1% of women and 13.8% of men were doing applied research.

3. Women are much less likely than men to work principally in development, and only half as likely as men to be engaged in the management of R & D. Within the total R & D effort in 1974, 23,500 women made up 5% of the 470,700 scientists and engineers so engaged. Among the 84,510 doctorates engaged in R & D in 1975, the 6,042 women were 7.1% of the total, and were 11.5% of those working in basic research but were only 3.9% of those in applied research, 1.9% of those working in development and 2.5% of those engaged in the management of R & D.

4. The number and proportion of women earning degrees in science and engineering has increased rapidly during the 1970's, although women's proportion of doctorates in these fields in the 1970's (13%) is only slightly above their proportion of earned doctorates in these fields in the 1920's (12.3%). The proportion of women scientists and engineers employed in academic settings and in industry also has increased, but more slowly than their share of earned degrees. Their proportion of the science and engineering work force as well as their proportion of research manpower remains below 10%.

5. Women doctoral scientists and engineers are more likely to work in academic institutions and less likely to work in business and industry than are men.

A. Among all doctoral scientists and engineers, 58.8% are employed in educational institutions whereas 70.3% of women are employed in this setting. Proportionately more women scientists and engineers than men are employed full-time in universities, and the higher the level of research expenditure or employment of scientists and engineers in these institutions, the higher the proportion of women within the full-time science and engineering work force. Insufficient data are available to ascertain the important demographics of these women (degree level, salary, principal work activity, academic rank, if any) that might explain this trend toward a higher proportion of women employed in the most research-oriented universities than in all universities. Is the employment of women scientists and engineers markedly different from the employment of women in other fields at academic institutions, or are more women employed as research assistants, outside of regular faculty tracks, at these institutions? While it is true that the proportion of women among full-time scientists and engineers is higher at the most research-oriented universities than at universities which employ fewer scientists and engineers, it is also true that the proportion of women among scientists and engineers employed in universities is smaller than their proportion in two-year institutions, as is also true for women as a proportion of all faculty in educational institutions. In 1976, women were 14.9% of full-time scientists and engineers employed at doctorate granting institutions but 20.4% of those employed at two-year institutions.

B. Among all doctoral scientists and engineers, 23% are employed in industry, but only 9.6% of all doctoral women scientists and engineers are so employed. Available data do not allow analysis of women's primary work activity in this employment setting to know whether a greater or smaller proportion of this segment of women are working in research than either the proportion of men scientists and engineers in this employment setting or than the proportion of all women scientists and engineers

who are working in research. In any case, the number of women researchers in industry is small.

C. Among women doctoral scientists and engineers, 4.7% are employed in federal government compared to 8.3% of all doctoral scientists and engineers, but no data are available to delineate the women working in research from those working at other activities within the government. The existing data indicate only that women scientists and engineers hold lower rank and draw lesser salaries than comparable men in the Civil Service, and that their opportunities for advancement are markedly less than for men at the same degree level.

6. Limited data on the labor force participation of women scientists and engineers seems at variance with available data on labor force participation of all women with similar amounts of education. Better data are required both to understand the actual participation of women trained in science and engineering and the reasons why those women out of the labor force are not at work or seeking work. Among doctoral women scientists and engineers, only 5.1% of those not retired were out of the labor force in 1975.

7. The unemployment rates of doctoral women scientists and engineers are three times higher than for men in every field of science, and are five times higher among young doctorates in the 30 to 34 age group.

8. No data are available to show any differences that may exist between minority and majority women scientists and engineers in terms of their primary work activity or their employment setting. Minority women constitute about 7% of all women doctorates in 1975, with Asian women making up 5% of all doctoral women scientists and engineers, black women 1.8% and American Indian women less than two-tenths of one percent.

9. Women scientists and engineers earn less than men in every field, at every degree level, at every level of experience, and in every employment setting. The

salary gap is increasing rather than decreasing.

10. Available data are inadequate to examine in any detail the characteristics of women scientists and engineers who are performing research. Surveys that are used to obtain much of the available data are samples of populations and include too few women to allow delineation of those characteristics which would show any significant differences between men and women performing research; or between women scientists and engineers working in research and those engaged in other activities. Further, where surveys of total populations are made, rather than using samples, the survey instruments do not request the information needed to separate by sex and cross tabulate for such characteristics as degree level or principal work activity. No current data are available on academic rank by field and sex, to say nothing of such refinements as by type and size of institution.

In populations such as scientists and engineers, where women are only a small proportion of the total workers, samples selected for surveys must be constituted by oversampling of women relative to men if any meaningful detailed data by sex are to be obtained. Further, and particularly where the population being surveyed is a 100% sample, additional questions are needed in the survey instrument and further analysis of the resultant data is prerequisite to obtaining real understanding of such characteristics as the labor force participation of women relative to men and of their activities in the scientific enterprise within each of the major employment settings. Only when such data are available can we determine in what ways women are treated or act differently than men; which differences may reflect a choice by women; and what efforts to include more women in any segment of science and engineering are likely to be most fruitful and valuable both to science and to scientists.

FOOTNOTES

1. National Science Foundation, "R & D Spending Reaches Nearly $41 Billion in 1977," NSF 77-306, p.1.

2. National Science Foundation, Characteristics of the National Sample of Scientists and Engineers, 1974, Part 1, Demographic and Educational, NSF 75-333, p. 7.

3. National Science Foundation, Characteristics of the National Sample of Scientists and Engineers, 1974, Part 2, Employment, NSF 76-323, pp. 53, 144.

4. National Science Foundation, U.S. Scientists and Engineers, 1974, NSF 76-329, pp. 27 - 28.

5. Ibid, p. 27.

6. National Science Foundation, "Largest Increase of Employment of Doctoral Scientists and Engineers Is In Industrial Sector: 1973-1975," NSF 76-326, p. 2.

7. National Science Foundation, Characteristics of Doctoral Scientists and Engineers in the United States, 1975, NSF 77-309, pp. 50 - 53.

8. Ibid, p. 115.

9. Ibid, pp. 62, 115.

10. National Research Council, Doctoral Scientists and Engineers in the United States, 1975 Profile, 1976, p. 17.

11. National Science Foundation, "Academic R & D Expenditures Up 9 Percent in FY 1976," NSF 77-314, p. 2.

12. National Science Foundation, Manpower Resources for Scientific Activities at Universities and Colleges, January 1976, NSF 77-308, pp. 9, 14 and Detailed Statistical Tables, NSF 76-321.

13. National Science Foundation, National Patterns of R & D Resources, Funds and Manpower in the United States, 1953-1977, NSF 77-310, p. 15.

14. National Science Foundation, "Self Supported Graduate Science Students Increased By 22% in 1975," NSF 76-320, p. 4.

15. National Science Foundation, Manpower Resources for Scientific Activities at Universities and Colleges, January 1975, Detailed Statistical Tables, Appendix B, NSF 75-329, p. 30.

16. National Science Foundation, "Self Supported Graduate Science Students Increased By 22 Percent in 1975," NSF 76-320, p. 5.

17. National Research Council, Summary Report, 1976 Doctorate Recipients from United States Universities, 1977, pp. 18 - 21.

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